出國報告（出國類別：開會）

參加全球合作暨訓練架構(GCTF)
舉辦「能源轉型的最佳實踐」專家工作坊
出國報告

服務機關：經濟部能源署
姓名職稱：鄭副組長如閔
派赴國家：馬來西亞
出國期間：113年5月1日至113年5月4日
報告日期：113年6月21日

內容摘要

應外交部邀請參加 2024 年 5 月 2 日由我國駐馬來西亞代表處、美國駐馬來西亞大使館、澳洲駐馬來西亞高專署與英國駐馬來西亞高專署在吉隆坡共同舉辦「全球合作暨訓練架構」（GCTF）「能源轉型的最佳實踐－對抗氣候變遷之專家工作坊」（Best Practices in the Energy Transition: A GCTF-Affiliated Expert Workshop on Combatting Climate Change），分享我國離岸風電政策與現況，另由工研院分享我國再生能源技術發展狀況，並拜會馬來西亞政府能源部門相關官員。

目錄

壹、目的及行程紀要

一、目的

應外交部邀請參加 2024 年 5 月 2 日由我國駐馬來西亞代表處、美國駐馬來西亞大使館、澳洲駐馬來西亞高專署與英國駐馬來西亞高專署在吉隆坡共同舉辦「全球合作暨訓練架構」（GCTF）「能源轉型的最佳實踐—對抗氣候變遷之專家工作坊」（Best Practices in the Energy Transition: A GCTF-Affiliated Expert Workshop on Combatting Climate Change），分享我國離岸風電政策與現況與我國再生能源技術發展狀況，拜會馬來西亞政府能源部門相關官員，了解馬來西亞能源轉型政策並建立聯繫管道，俾利未來雙方交流合作。

二、行程紀要

2024年5月1日（星期三）		備註
13:25	抵達吉隆坡KLIA國際機場	
2024年5月2日（星期四）		
09:00~ 14:00	參加GCTF Workshop	詳如議程表
2024年5月3日（星期五）		
10:00	拜會馬來西亞經濟部能源司司長Dr. Afiza Idris 地點：Energy Division, Level 3, Ministry of Economy, Menara Prisma, Presint 3, Putrajaya	
15:30	拜會馬來西亞能源及水務轉型部能源永續司司長 Mr. Asdirhyme bin Abd Rasib 地點：Amber Meeting Room Level 4, Menara PETRA, Persiaran Perdana, Presint 4, Putrajaya	
2024年5月4日（星期六）		
14:55	返臺	

貳、過程

一、GCTF Workshop(會議紀要及重點)

（一）會議時間：2024 年 5 月 2 日

（二）與會人員：我國駐馬來西亞代表葉非比大使、美國駐馬來西亞大使 Edgard Kagan 及英國駐馬來西亞高專 Ailsa Terry、馬來西亞能源轉型暨水利部副秘書長 Mohamad Razif bin Abdul Mubin 與馬來西亞產、官、學及金融界等單位約 70 人出席。

（三）會議議程

Tentative Agenda for Best Practices in the Energy Transition: A GCTF-Affiliated Expert Workshop on Combatting Climate Change

Overview: The Global Cooperation and Training Framework (GCTF) plus the United Kingdom present a workshop designed to bring together thought leaders, policymakers, and experts from various economies, including the United States, Taiwan, Australia, and the United Kingdom, to share insights, experiences, and best practices in the transition to renewable energy and the broader fight against climate change.

Date: May 2, 2024

Location: JW Marriott Kuala Lumpur

8:30	Registration/ Light Breakfast
9:00	Welcome by Hosts
9:05	Remarks by Representative Pheobe Yeh, Taipei Economic and Cultural Office in Malaysia
9:15	Welcoming Remarks from U.S. Ambassador Edgard Kagan
9:20	Keynote Speech UK High Commissioner Ailsa Terry Keynote
9:50	Coffee Break
10:05	**Session One - Future Trends in Renewable Energy:** Taiwan and Australian representatives will discuss technology developments and policies driving the future of renewable energy. Expert speakers will highlight technology developments, policies, funding, and regulatory frameworks that drive the energy transition in Taiwan, Australia, and Malaysia.
11:15	**Session Two - Expert Talk:** Subject matter experts will discuss Taiwan's experience growing its offshore wind ecosystem as part of a broader transition to renewable energy.
11:45	Coffee Break
12:00	**Session Three- Comprehensive Financing Strategies for Renewable Energy Projects:** This session will highlight their initiatives, funding mechanisms, and ongoing support for sustainable energy development via a panel featuring banks from the United States, UK, and Malaysia that delves into how these institutions navigate government regulations to promote investment in green projects. The panelists will discuss innovative financing strategies, market incentives, and the crucial role of regulatory frameworks in accelerating sustainable finance.
1:30	Lunch

（四）會議紀要

1. GCTF 在 2015 年 6 月由臺灣與美國共同成立，日本、澳洲與理念相近國家相繼加入，展現臺灣積極貢獻國際社會能量，並已成為能力建構重要國際平臺。自 2021 年起以加盟模式舉辦 GCTF 海外活動，本活動為第二度在馬來西亞舉辦 GCTF 國際研討會。此研討會係由我國駐馬來西亞代表處、美國駐馬來西亞大使館、澳洲駐馬來西亞高專署與英國駐馬來西亞高專署等聯合舉辦，此為外交部在馬來西亞與各國駐外使館的例行性活動，今年為第二屆舉辦，每年均挑選不同主題，今年主題為能源轉型與氣候變遷，研討會全名為「全球合作暨訓練架構」（GCTF）「能源轉型的最佳實踐—對抗氣候變遷之專家工作坊」（Best Practices in the Energy Transition: A GCTF-Affiliated Expert Workshop on Combatting Climate Change），聚焦對抗氣候變遷、能源轉型及促進綠能融資等議題。現場共有馬來西亞產、官、學及金融界等單位約 70 人出席。

2. 我國駐馬來西亞代表葉非比大使、美國駐馬來西亞大使 Edgard Kagan 及英國駐馬來西亞高專 Ailsa Terry 開幕致詞。

3. 馬來西亞能源轉型暨水利部副秘書長 Mohamad Razif bin Abdul Mubin 說明馬來西亞能源轉型現況。

(1)2023 年 7 月馬來西亞宣布 NETR(National Energy Transition Roadmap) 第一階段轉型路徑，涵蓋能源效率、再生能源、氫能、生質能、綠色運輸和 CCUS 等六大領域，8 月公布第二階段確立 2050 年淨零具體路徑，將逐步淘汰煤炭燃料，提升再生能源發電占比，強化需求面管理，優化工業、商業、住宅和交通的能源效率，加速交通運輸電氣化和生物燃料轉型。結合補貼、貸款優惠、激勵等支持性措施，推動相關產業轉型，同時確保能源安全、能源公平和經濟平衡發展。

(2)馬來西亞為鼓勵各行業，推出綠色技術獎勵措施，針對從事合格綠色活動的公司有綠色投資稅收減免(GITA) 和綠色所得稅豁免(GITE)等措施推動相關產業轉型，預計帶來 54.81 億美元投資額，創造 2 萬個以上高階就業機會，同時每年減少 1 萬瓩二氧化碳排放。

(3)NETR 政策目標:

a. 2025 年前使再生能源的發電量占比達 35%、2035 年前達 40%、2050 年前 70%。

b. 擴大設置再生能源，鼓勵投資再生能源價值鏈。

c. 擴大政府公有建築安裝太陽能系統。

d. 建立電力交易系統允許跨境再生能源交易。

e. 推動東協電網(ASEAN Power Grid, APG)計畫進一步發展，成為區域再生能源中心。

4. 研討議題

(1)議題一：

a.臺灣與澳洲專家進行演講後進行討論,臺灣由工研院鄭明山副所長簡介工研院、臺灣能源轉型方向及工研院重要科技研發成果與未來方向(附件 1)。澳洲由 Becky-Jay Harrington 分享在氣候變遷下，能源系統遭遇挑戰，未來能源系統規劃，除了考慮低碳外，也要考慮如何提高韌性(附件 2)。同時分享澳洲相關再生能源韌性之研究，如澳洲風力發電在極端高溫(45˚C)時空氣密度改變會造成輸出下降，相同風速下輸出僅有設計容量 40%。澳洲採用 Integrated System Plan (ISP)，考量韌性與其他因素，來做未來能源系統規劃。澳洲電網規模與臺灣相當，目前大力發展再生能源與儲能，現有 2GW 儲能(包含電池、抽蓄水力等)，規劃 2030 目標 15GW 儲能，2050 目標 61GW 儲能。風力與太陽光電現有 15GW，規劃 2030 目標 44GW，2050 目標 141GW。

b.討論：

(a)對臺灣 TopCon 太陽能板效率可以提升狀況，跟是否有商業競爭力提問，講者分享工研院 TopCon 技術的生產成本並不會比傳統生產更高，產線的更動極少，廠商可以利用現有設備生產，無需大額投資。

(b)對臺灣如何提高能源效率做法提問，講者分享主要是透過政府政策法規與補助推動臺灣能源效力提高。

(2)議題二

a.經濟部能源署分享臺灣風力發電政策與推動成果(如附件 3)。

b.與會者關切臺灣在發展離岸風電過程中,如何保護海洋生態,分享我國離岸風電開發選址即須避開敏感區位,並經環境影響評估,至於海洋生態部分,業者須進行完整海洋生態監測,提出生態保護與監測計畫,並經環境影響評估委員會審核通過,才有機會取得風場開發權利。另有與會者關切臺灣離岸風電開發機會,說明臺灣離岸風電已有一定成果,且設置目標明確，歡迎國外廠商參與。

(3)議題三

美國、馬來西亞金融界(滙豐銀行、美國銀行(Bank of America)、美國國際發展金融合作(US International Development Finance

Cooperation)、馬來西亞銀行)分享財務與金融工具在淨零排放領域的應用

a. 美國銀行以臺灣推動離岸風電為例，政府有很明確政策與路徑規劃，透過示範計畫驗證技術可行，加上有很多國家 ECA 都有參加投資，可以加強銀行對 PROJECT 的信心，另 PPA 機制有固定現金流，對銀行投入也有一定吸引效果。另外澳洲有政府支持的綠色銀行，融資給再生能源相關投資案對於降低投資成本有一定效果。澳洲電價是自由市場，政府需要提供電網支持，投資專案才有辦法如期。美國沒有停止燃煤電廠，是基載電源會視效率決定，哪一種電力組合是最適化最有利的，要靠數據才能判斷。

b. ASEAN 國家有許多燃煤電廠仍相對年輕，建造時間大約 10~15 年，如果過早地淘汰這些電廠，在財務上會有風險，另一個角度是燃煤電廠員工的就業問題。使用 Biomass 或 NH3 可能是解決方案。馬來西亞的國家能源轉型倡議(National Energy Transition Initiatives)已規劃未來再生能源，基本方向正確。石油公司(Oil & Gas)仍將在未來的能源市場扮演要角，但是重心將轉往離岸風電與 CCS，這些項目需要石油公司的專業。目前的金融業大多關注綠電，較少關注調適議題，此點在未來應該要改變。馬來西亞目前僅投資 2~3 百萬在調適，應該加大關注力道。

c. 匯豐銀行大力投入綠色放貸與投資，主要透過放款、PPP 等手段。近年準備 10 億美金特別針對新興科技的大規模建置,在菲律賓已經提供 1,300 萬美金放款協助太陽光電發展。保險公司可協助降低風險，全球的退休基金對綠色金融已產生興趣並開始投資。

圖一 研討會開幕主辦單位與講者合照

圖二 GCTF 研討會現場照片

圖三 能源署分享臺灣風力發電政策推動成果照片

二、拜會馬來西亞經濟部能源司

（一）時間：2024 年 5 月 3 日上午

（二）與會人員：

1．臺灣：駐馬來西亞經濟組章組長遠智及章秘書凱婷、政策組施秘書建志、能源署鄭副組長如閔、工研院鄭副所長名山

2．馬來西亞：能源司司長 Dr. Afiza Idris、組長 Mohd Fauzi Mustafa、PETRONAS 顧問 Dr.Abang Ashaari Abdul Rahman

（三）會談摘要

馬來西亞經濟部能源司負責能源政策規劃，司長分享馬來西亞能源轉型規劃及透過整合政府與業界意見所規劃 10 大轉型計畫，包含能源效率、再生能源、氫能、生質能、綠色運輸、CCS 等，並說明能源轉型是很大投資，需要透過技術研發來降低成本，能源轉型主要發展項目為 PV、生質能、水力，各項能源轉型策略與計畫均有領導業者協助推動，以 CCS 為例，由國營石油公司 PETRONAS 主導，規劃在 2030 開始運作目標封存 1500 萬噸，2050 年目標封存 4000 萬~8000 萬噸，將採 EOR 方式辦理，碳源有考慮從海外輸入。

我方分享能源轉型政策方向與目前成果，關切我國電網有無與他國連結之計畫，對核能與 SMR 看法及如何促使企業參與能源轉型。

透過本次拜會，建立與馬來西亞能源部門聯繫管道，有利未來雙方的交流合作。

圖四 拜會馬來西亞經濟部能源司

三、拜會馬來西亞能源及水務轉型部能源永續司

(一)時間：2024 年 5 月 3 日下午

(二)與會人員：

1.臺灣：駐馬來西亞經濟組章組長遠智及章秘書凱婷、政策組施秘書建志、能源署鄭副組長如閔、工研院鄭副所長名山

2.馬來西亞: 能源及水務轉型部永續能源司主任秘書 Zamzurina Binti Zulkifli、能源效率科 Dr.Ida syahrina Binti Haji Shukor

(三)會談摘要

能源及水務轉型部永續能源司任務係執行經濟部能源司所訂定能源轉型計劃。馬方分享 2050 淨零路徑，能源效率將貢獻 20%減碳量，規劃 2025 年要達到電網電力供應絕對減量 8%，具體作法包括提升 MEPS 標準、建築法規加嚴(Building Code)、新用電管制措施及鼓勵工業區自行發電，以減少電網供電壓力。預計在 2024 年 7 月通過節約能源法(Energy Conservation Act)，透過建築法規(building code)修正、擴大升級 MEPS、工業能源查核、熱能使用規範、能源管理促進節能。

我方分享我國能源現況及馬方較有興趣能源效率政策。

圖五 拜會馬來西亞經濟部能源司

參、心得與建議

我國離岸風電推動政策與成果獲與會人員肯定，金融業者以我國有明確政策與路徑可做為馬來西亞國家推動再生能源之參考，實際推動成果更有助於金融業者與相關國際投資者投入信心。

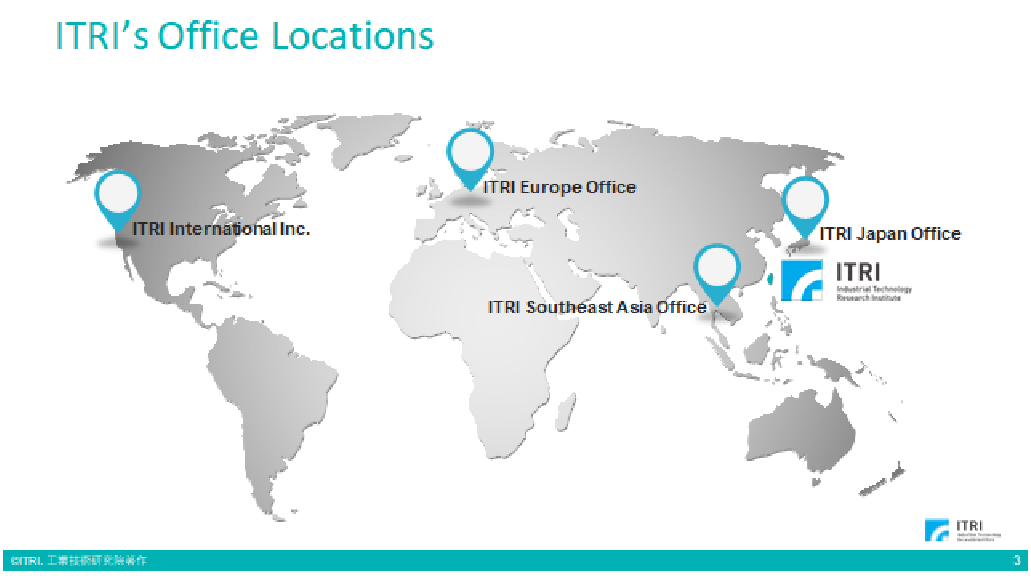
於國際分享我國離岸風電成功案例，除吸引國外業者投入我國離岸風電推動有實質助益外，同時有助國際了解我國推動再生能源與能源轉型具體成效。

馬來西亞已規劃 2050 年淨零碳排，透過「國家能源轉型路線圖」包括能源效率、再生能源、氫能、生質能源、綠色交通與碳捕捉封存再利用(CCUS)等六大能源領域來逐步達成。其中再生能源發電占比目標，預計至 2025 年占總發電量之 31%、2035 年占 40%及 2050 年占 70%，以太陽光電與水力為主要發展項目，另 CCUS 則借重國營石油公司規劃 2030 年存 1500 萬噸目標量，氫能則未來規劃透過豐沛水力所產綠電產氫。

我國與馬來西亞均以 2050 年淨零碳排為目標，可透過能源轉型共同發展項目如再生能源、氫能、CCUS 等進一步就政策、技術促進交流合作。

肆、附件

附件 1 臺灣鄭明山副所長介紹工研院及重要科技研發成果與未來方向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Green Energy and Environment Research Laboratories (GEL)
Low-Carbon Environment
• Sustainable Environment
(Resource Circulation Technology, Pollutant Prevention)
• Low Carbon Energy and Energy Storage
(Bioenergy, Hydrogen, Geothermal, Marine Resources, CCS)
Energy Efficiency
• Smart Energy-saving System
(Sensing and Monitoring, EMS, smart lightening, control and simulation analysis)
• Energy-saving Equipment
(High-Speed Turbomachinery, ORC)
Electrical Energy System
• Photovoltaics (PV)
(Photovoltaic System and Reliability Advanced Photovoltaic Material)
• Grid and Power Electronics
(Smart Grid, Virtual Power Plant (VPP))
Environmental and Energy Policy
• Policy and Promotion
(Net Zero Strategy, Energy, Environmental & Social Planning)
• Green Energy Industry Promotion
(PV, Wind)
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Outline

- Global Renewable Energy Development Trends
- Taiwan's Renewable Energy R&D Development
- Hydrogen: The Next Frontier of Clean Energy
- Concluding Remarks

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Global Renewable Energy Development Trends

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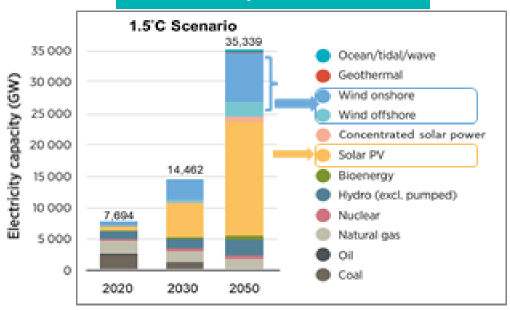
Net-zero Goal Drives Robust Growth in RE

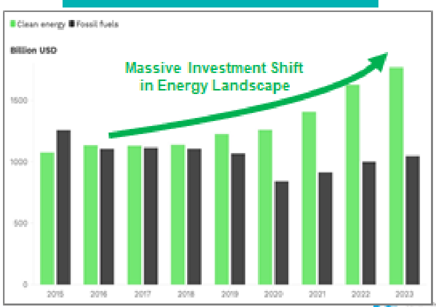
- Renewables must triple by 2030 to be on track with major net zero scenarios.
- In 2050, solar power and wind power will be the dominant source of generation. Geothermal, ocean and bioenergy will also play significant role in power generation.
- Investment has shifted from fossil fuel to clean energy (renewables, hydrogen, energy efficiency improvement, grids and storage, etc.)

Development Trend



Source: IRENA (2024)

Investment Trend

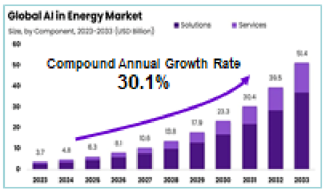


Source: International Energy Agency (2024)

Imagining the Future of Energy System

Digitalization

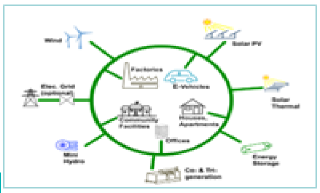
- The growing AI application is revolutionizing energy sector



Source: AI in Energy Market Trends: Towards USD 51.4 Bn by 2033 (2024)

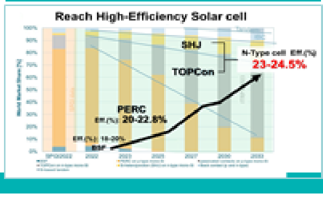
Decentralization

- Electrical power is shifting from "Grid Centric" to " Customer Centric"



Source: UNITED ENERGY VENTURES

High-efficiency RE



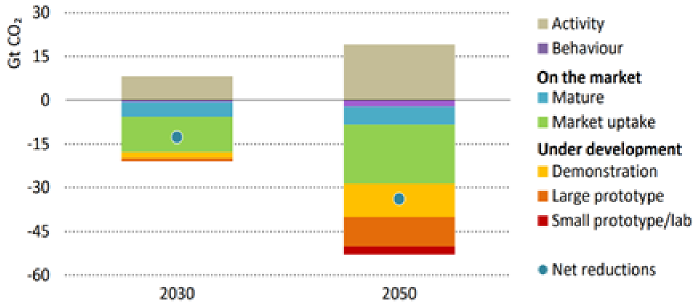
- Need innovative technology to improve energy efficiency and power generation

Source : ITRPV, 2023

ITRI

R&D Plays an Important Role in Net-zero Emissions

- More than 400 technologies are needed, nearly 1/3 are still in the developing stage.
- Reaching international energy and climate goals requires a "sharp acceleration in clean energy innovation"



Source: IEA(2021), NET ZERO BY 2050 A ROADMAP FOR THE GLOBAL ENERGY SECTOR.

ITRI

R&D Plays an Important Role in Net-zero Emissions

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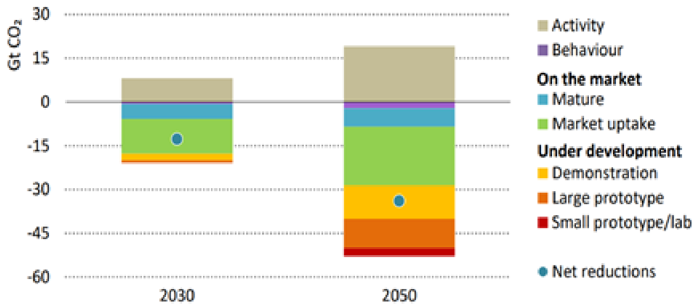

Source: IEA(2021), NET ZERO BY 2050 A ROADMAP FOR THE GLOBAL ENERGY SECTOR.

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Taiwan's Renewable Energy R&D Development

Taiwan 2050 Net Zero Policy and Strategy

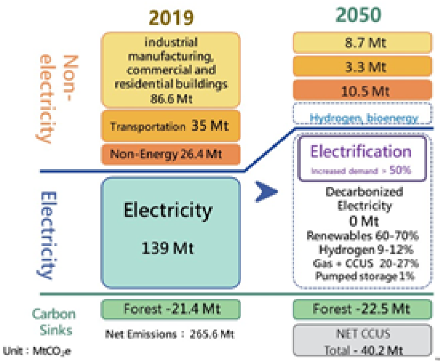
- Taiwan 2050 net-zero committed by President Tsai in April 2021.
- National Development Council released Pathway to 2050 net zero in March 2022.
- A challenging goal that calls for **multi-disciplinary collaboration** and **innovation.**

4 Major Transition Aspects:
Energy, Industry, Lifestyle, Social

2 Governance Foundations:
Technology R&D, Climate Legislation

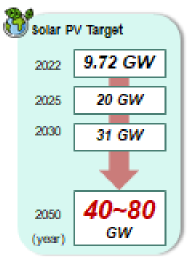
12 Key Strategies:

1. Wind/Solar PV
2. Hydrogen
3. Innovative Energy
4. Power Systems & Energy Storage
5. Energy Saving & Efficiency
6. CCUS
7. Carbon-free EVs
8. Recycling & Zero Waste
9. Carbon Sinks
10. Green Lifestyle
11. Green Finance
12. Just Transition

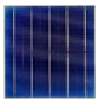


Solar Photovoltaic Development

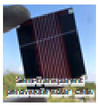
- Given the limited land availability in Taiwan, **high-efficiency module** has been the R&D focus in order to generate the most electricity from limited land.
- Diverse symbiosis applications and smart O&M to increase the benefits, such as **fishery-PV**, **agrivoltaics** and **floating photovoltaics**.



High Efficiency Photovoltaics



TOPCon solar cell
- 24% efficiency
- upgraded from existing production lines

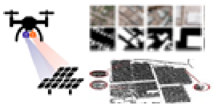


Perovskite-silicon Tandem Cell
- 25.1% Efficiency
- Perovskite-silicon 4T type tandem architecture

Dual-use Solar Photovoltaic System

Integrated economic model
- Combining aquaculture or agriculture with PV system

PV System O&M



Drone inspect in PV system
- Image data combine with AI recognition to monitor the aging level of the system

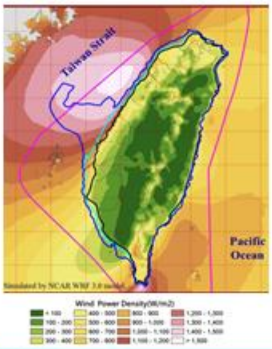
O&M: Operation and Maintenance

Offshore Wind Power Development

- **Taiwan strait is a world-class site for offshore wind farms.**
- Three phases of developing offshore wind: demonstration, potential site selection, zonal development.
- Application of machine-learning and other AI techniques to achieve accurate **prediction of wind power generation**, and **intelligent O&M** will be R&D focus.

Offshore wind power Target

(year)	
2022	237.2 MW
2025	5.6 GW
2030	13.1 GW
2050	40~55 GW



Wind Energy Assessment

- Long-term environmental data
- Annual power generation estimates
- 168-hour metocean forecast
- Smart power dispatch

Smart Maintenance of Offshore wind

Drone Inspection

Sea Cable Monitoring

Early warning system

Wind Turbine Construction Early Warning

Geothermal Base-load Energy

- Taiwan is situated in the Pacific Ring of Fire, possessing **abundant geothermal resources.**
- **Precise geothermal capacity testing** system and **geothermal potential assessment** to reduce the initial investment risk.
- Remote real-time monitoring and FDD (fault detection and diagnosis) of power plant components to achieve **intelligent power plant management.**

Geothermal Target

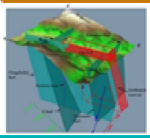
(year)	
2025	20 MW
2030	56~192 MW
2050	3~6.2 GW

Smart Production Testing System

The world's first precise testing system

- High precision (error <0.5%)
- Integrated all-in-one cabin
- Rapid sampling

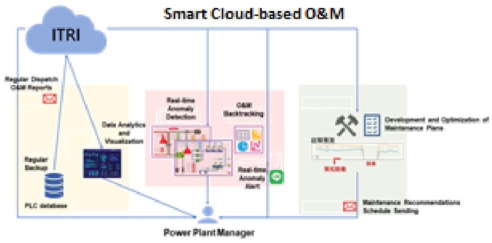
Geothermal Potential Assessment



- 3D conceptual model of the reservoir
- Slim-hole Drilling & Logging for geological and groundwater investigation

Intelligent Geothermal Power Plant

Smart Cloud-based O&M



- Remote monitoring system
- Pre-diagnosis of the component health conditions.
- Reservoir operation, maintenance and management

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Enabling RE Reliability – EMS and Energy Storage

- **EMS (Energy Management System) and energy storage** are crucial to ensure stable electricity supply, especially in a decentralized system.
- Application of AI techniques helps improve the system operation.

ITRI's Prototype of 1 MVA PCS for Energy Storage System

- ESS PCS
  - 100~1000 kVA
- Solar PV Inverter
  - 5~200 kVA

Demonstration and verification since 2017 in ITRI south campus

- 430kW Solar PV
- 500kW/1MWh ESS
- 5kW Biomass generation
- 200kW Backup gen.
- Load 150~700kW

- Smoothing of solar output
- Control of smart inverter
- Power flow control at interconnection point
- Peak reduction of load

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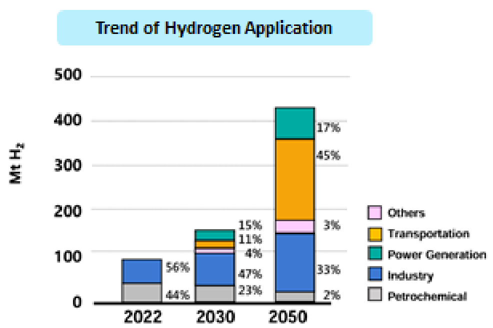
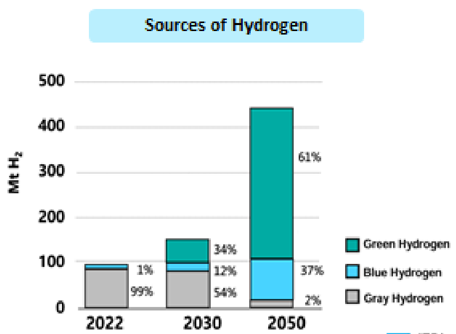
Hydrogen: The Next Frontier of Clean Energy

Global Trend of H_2 Application and Production

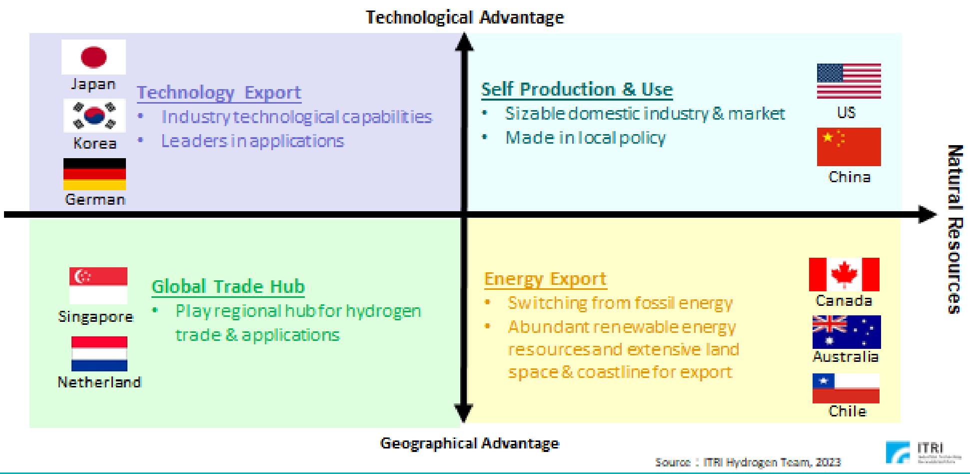
- Hydrogen is vital for achieving net-zero emissions or carbon neutrality goals globally.
- Hydrogen applications mainly include power generation, industry usage, and transportation.
- IEA forecasts that global hydrogen demand is expected to reach 430 million metric tons in 2050.



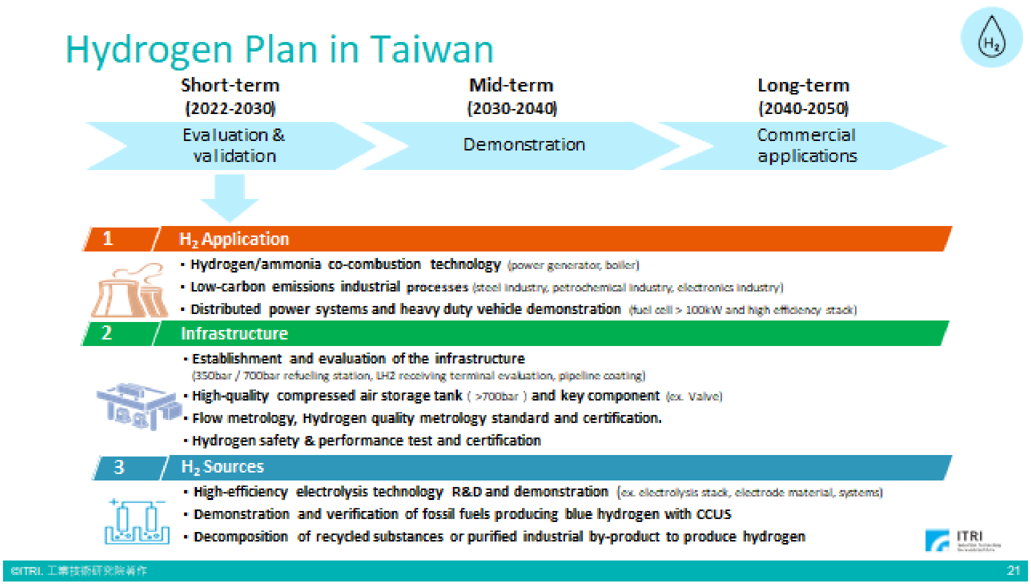


Source：IEA (2023)

Hydrogen Development Priorities Across Nations



Source：ITRI Hydrogen Team, 2023



Hydrogen Plan in Taiwan
Short-term
(2022-2030)
Evaluation & validation
Mid-term
(2030-2040)
Demonstration
Long-term
(2040-2050)
Commercial applications
1
H2 Application
• Hydrogen/ammonia co-combustion technology (power generator, boiler)
• Low-carbon emissions industrial processes (steel industry, petrochemical industry, electronics industry)
• Distributed power systems and heavy duty vehicle demonstration (fuel cell > 100kW and high efficiency stack)
2
Infrastructure
• Establishment and evaluation of the infrastructure
(350bar / 700bar refueling station, LH2 receiving terminal evaluation, pipeline coating)
• High-quality compressed air storage tank (>700bar) and key component (ex. Valve)
• Flow metrology, Hydrogen quality metrology standard and certification.
• Hydrogen safety & performance test and certification
3
H2 Sources
• High-efficiency electrolysis technology R&D and demonstration (ex. electrolysis stack, electrode material, systems)
• Demonstration and verification of fossil fuels producing blue hydrogen with CCUS
• Decomposition of recycled substances or purified industrial by-product to produce hydrogen
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ITRI's International Partnerships in Hydrogen
Fostering Technological Advancement Through International Collaboration
Production
Green Hydrogen Production
• Tokuyama (JP), GEL/MCL/ISTI (ITRI)
• AEM electrolysis system
Transport
Pipeline Detection
• AIST (JP), GEL/CMS/ISTI (ITRI)
• Hydrogen leakage detection
Storage
Liquefied Hydrogen Terminal
• Kawasaki (JP), GEL/CMS/ISTI (ITRI)
• High pressure hydrogen storage demonstration
Application
Decentralized Electricity
• GEL (ITRI), Asia Hydrogen Energy/Chinese Petroleum Corporation (TW) ,etc.
• 25 kW SOFC
GEL: Green Energy and Environment Research Laboratories, ITRI
MCL: Material and Chemical Research Laboratories, ITRI
ISTI: Industry, Science and Technology International Strategy Center, ITRI
CMS: Center for Measurement Standards, ITRI
AIST: National Institute of Advanced Industrial Science and Technology, Japan
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Shalun Hydrogen Demonstration Site in Taiwan
Partnering domestic and overseas manufacturers to establish Taiwan's first comprehensive hydrogen energy demonstration park by 2025
H2 Production
Hundred-Watt Scale Electrolysis Hydrogen Production System Verification
H2 Production
Domestic-developed electrolysis system
Power Generation
Hybrid Fuel Cell Power Generation System Verification
Energy Storage
Composite Energy Storage Management Control System - Hydrogen/Battery Control
Transportation / Infrastructure
Vehicle Applications and Planned Location for Mobile Hydrogen Refueling Stations
H2 Storage
Hydrogen storage area (350 bar)
• Energy Generation : PV 1MW · Fuel Cell 50 kW
• Energy Storage : 40 kW/200 kWh
• Energy Saving: Green building test platform
• System integration and distribution: Energy center
SOFC: Solid Oxide Fuel Cell; NG: Natural Gas; LNG: Liquefied Natural Gas
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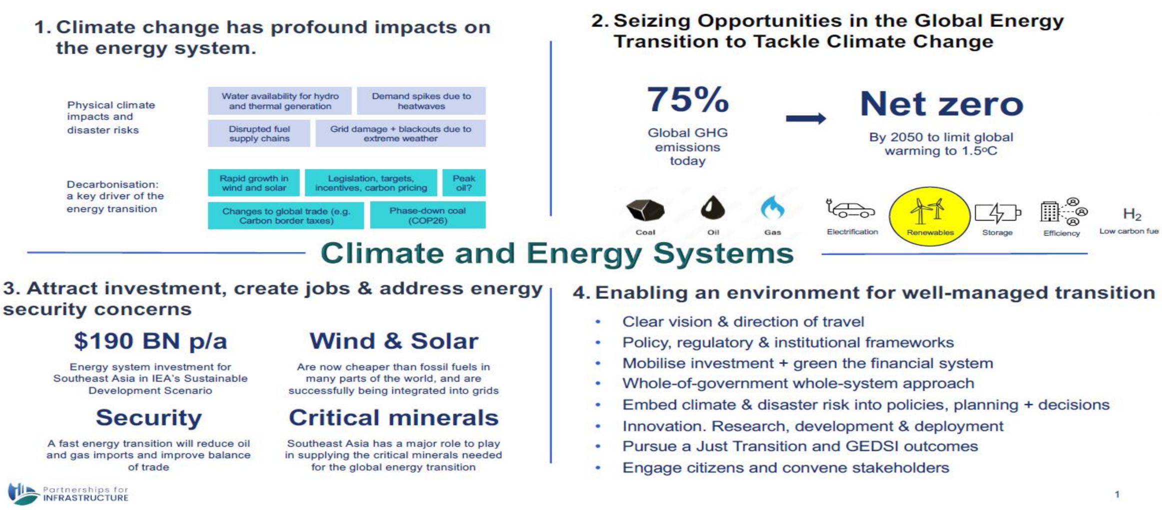
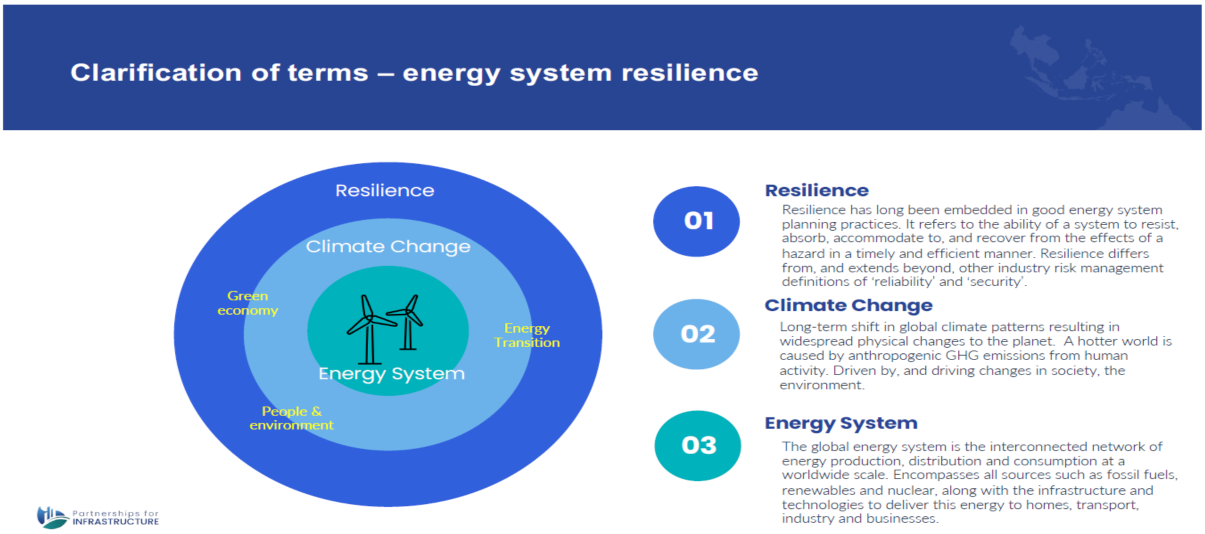
Innovating for a Better Future
Achieving net-zero emissions by 2050 is a global consensus
Energy transition relies heavily on the deployment of RE
Digital thinking helps create high-value applications
Hydrogen technology needs global cooperation to accelerate the progress.
Photo: Green Energy Technology Demonstration Site in Shalun
23

附件 2 澳洲 Becky-Jay Harrington 分享 Climate Change as a Future Trend of Renewable Energy

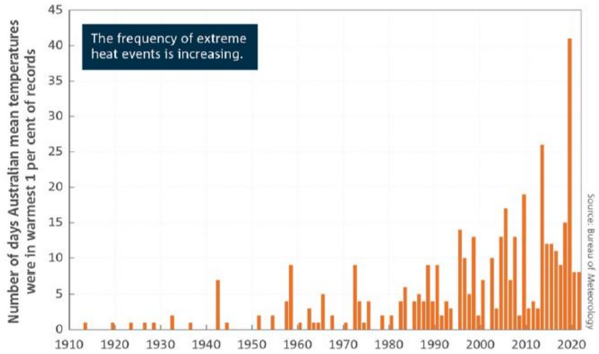




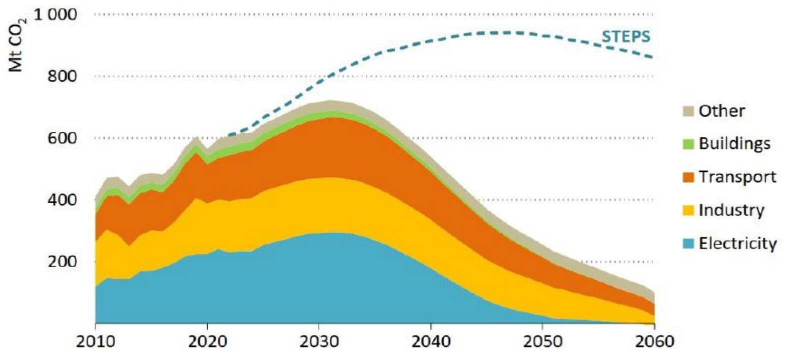
Climate Change in Australia

Australia is especially vulnerable to the impacts of climate change.

- Record-breaking hot days and larger, more frequent bushfires
- More intense, heavy rainfall causing frequent and more damaging floods
- Mass coral bleaching on our heritage-listed reefs
- Rising sea levels and coastal erosion.



Different pathways to net zero energy, but all require electrification, renewables and a strong shift away from coal



Total CO_2 emissions peak around 2030 in the APS at a level that is about 10% lower than in the STEPS in the same year; by 2040 emissions are 10% lower than today

Partnerships for INFRASTRUCTURE

4

Electricity system (including Renewables) vulnerability will become increasingly important as more of the global economy electrifies

Climate hazards impact all parts of electricity systems:

- Generation
- Transmission & distribution networks
- Demand

Without action, these impacts will worsen as global temperatures increase.

Yet many countries do not yet have robust climate change risk assessments or resilience plans.

Climate/Extreme weather risk*	Generation	Transmission and Distribution	End use/ Demand side
Rising temperature/ water scarcity	Loss of efficiency in thermal, solar, hydro generation	Reduced grid efficiency, high transmission losses	Potential power outage even as demand for cooling rises
Rising sea level/storm surges	Inundation of coastal generation and grid infrastructure	Inundation or disruption of lines	Coastal communities, mini and microgrids impacted
Extreme storms/high wind speeds	Port and road closure, efficiency of wind and solar energy impacted	Aboveground systems at risk of disruption	Power outage may impact critical services such as healthcare
Operations	Existing operational guidelines, codes, equipment standards, personnel trainings may fall short of addressing climate risks		

Source: Rocky Mountain Institute (2021)

Partnerships for INFRASTRUCTURE

5

Renewables can help to diversify energy supply, in turn supporting climate resilience and energy independence goals

- **Extreme droughts led to a significant decrease in hydropower output in 2023, particularly in China, the United States, and other economies.**
- **This shortfall in hydropower accounted for over 40% of the emissions increase as countries relied more heavily on fossil fuels to compensate.**
- Hydro capacity is expected to increase in the region, with ambitious hydro development plans.
- Over reliance on hydro power can bring risks
- Renewables like solar PV can help mitigate these impacts through diversification and by complementing hydropower.
- Climate impacts on hydropower and resilience criteria should be integrated into energy modelling and planning.

Partnerships for INFRASTRUCTURE

6

Climate and disaster resilience measures are needed at asset, network and system levels. Governments, utilities & regulators have critical roles.

Climate risk assessments. Climate data & scenarios. Uncertainty. Adaptive planning.

Energy assets
- Physical hardening e.g. underground power lines
- Design parameters e.g. temperature thresholds
- Retreat / relocation

Energy networks & systems
- Integrated resource and resiliency planning
- System flexibility e.g. storage, demand side response, interconnection
- Generation adequacy and diversity of sources
- Grid resilience and redundancy e.g. microgrids and defensive islanding
- System operations (e.g. security-constrained dispatch)

Beyond the energy system
- Regulation, incentives & governance
- Resilience of interconnected infrastructure systems e.g. transport, telco
- Land-use planning (e.g. impacts flooding, bushfires etc.)
- Disaster response and recovery
- Community resilience

Partnerships for INFRASTRUCTURE

7

And resilience needs to be integrated across a broad range of Government functions. Utilities, regulators and communities also have key roles

Typical Government functions relevant to energy resilience (not all functions are included)

- National cross-sector strategies (Adaptation Plans, Resilience Frameworks, Climate etc.)
- Energy strategy, planning & financial management
- Energy policy, regulation & pricing / tariffs
- Grid networks, asset management, system operation
- Project life-cycle – generation (IPPs), storage etc.
  - Feasibility, approvals & procurement
  - Monitoring construction & operations
- Communities & energy users
- Innovation, science, research, data

Partnerships for INFRASTRUCTURE

8

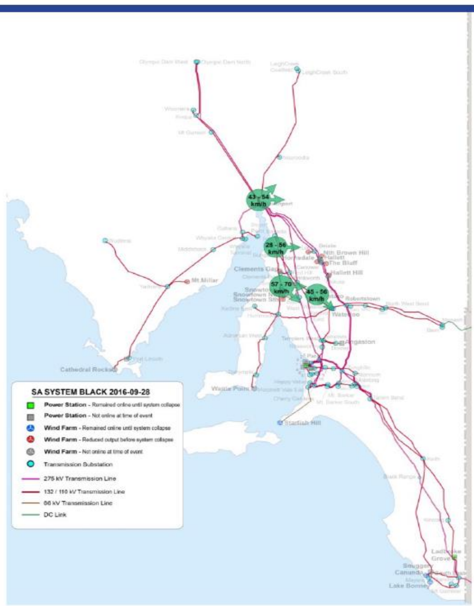
Australia - A renewable energy superpower

Renewables will provide >80% of electricity in the National Energy Market in Australia by 2030

1. **Renewables & Distributed Energy Resource**
2. **Grid infrastructure investments**
3. **Energy efficiency**
4. **Electrifying Transport**
6. **Hydrogen**
7. **Critical minerals**
8. **Energy system resilience**
9. **Sustainable finance taxonomy**

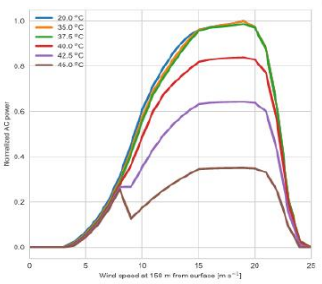
Partnerships for INFRASTRUCTURE

Finkel Review – South Australia's 2016 blackout



Australia's Electricity Sector Climate Information (ESCI) Project

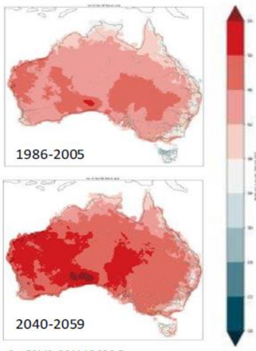
Step 1: Establish the historical relationship



Wind farm output as a function of temperature and wind speed

The Bureau of Meteorology

Step 2: Analyse climate projections



CanESM2-CCAM RCP8.5

Step 3: Assess potential impact

A wind farm near Adelaide on a 1-in-10 year hot summer day (current climate) could expect an output of ~40% of maximum.

In the future the output on a 1-in-10 year summer day is expected to drop to ~0%.

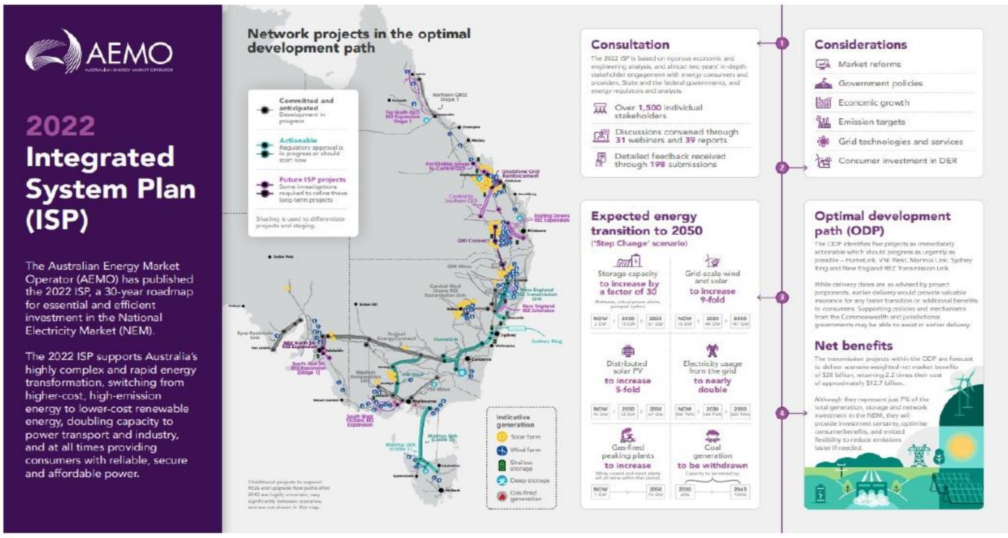
Electricity supply may be less reliable in a warmer climate.

9

Partnerships for INFRASTRUCTURE

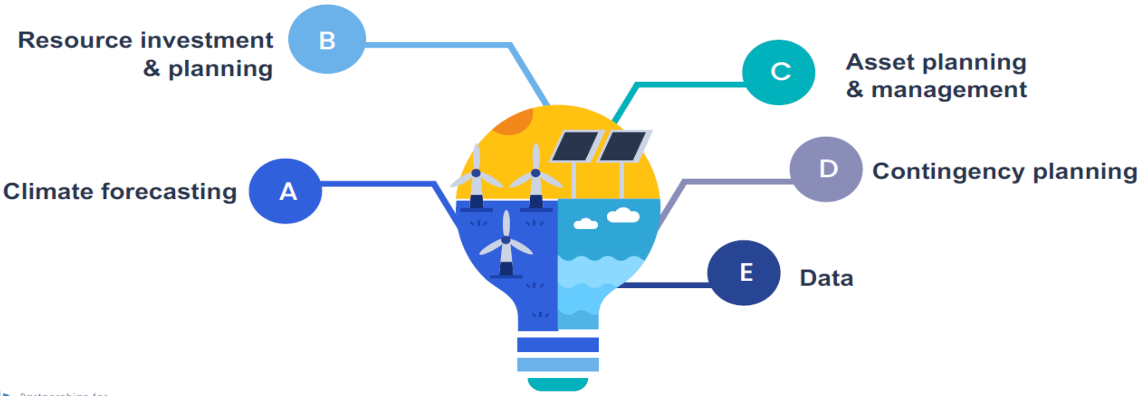
11

Australia's Integrated System Plan (ISP)



Energy Regulator's role in building Energy system resilience

Marketing is the study and management of exchange relationships. Marketing is the business process of creating relationships with and satisfying customers.



The huge levels of investment required for the energy transition offer opportunities to address both the causes and effects of climate change

$1.8 Trillion global investment in clean energy in 2023 (USD)

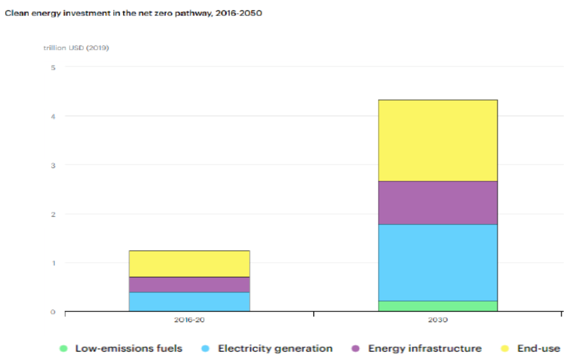
$25-30 BN for Southeast Asia in 2021

$4.5 Trillion annual global investment in 2030s to align with net zero by 2050

$190 BN p/a for Southeast Asia

$100 BN annual global concessional funding required to mobilise private capital

This investment must be leveraged to integrate resilience into infrastructure planning and delivery.



Climate resilient energy systems will be critical for achieving broader economic, social and development objectives

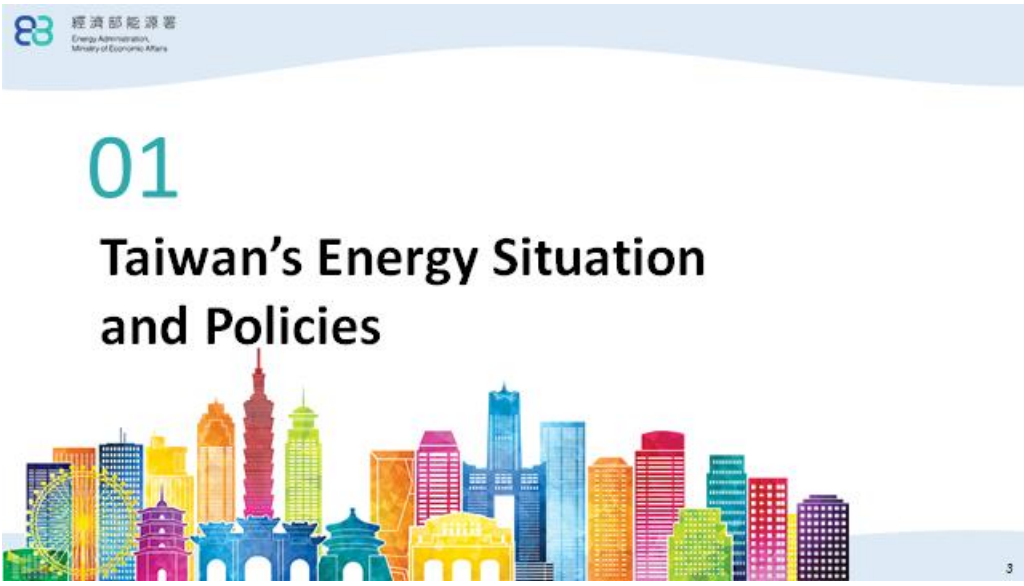
Makes economic sense + supports development

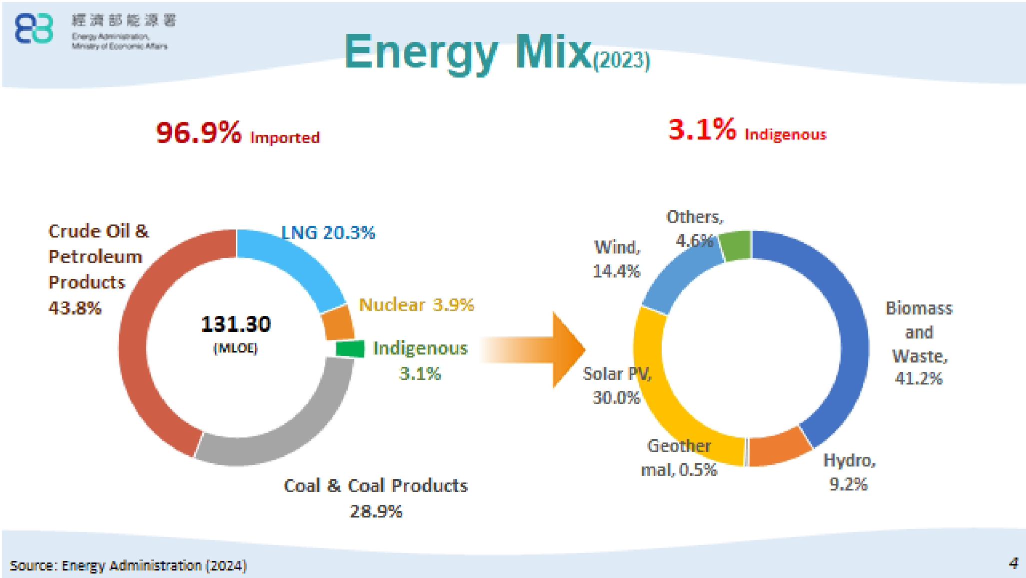
Builds social resilience and supports energy access

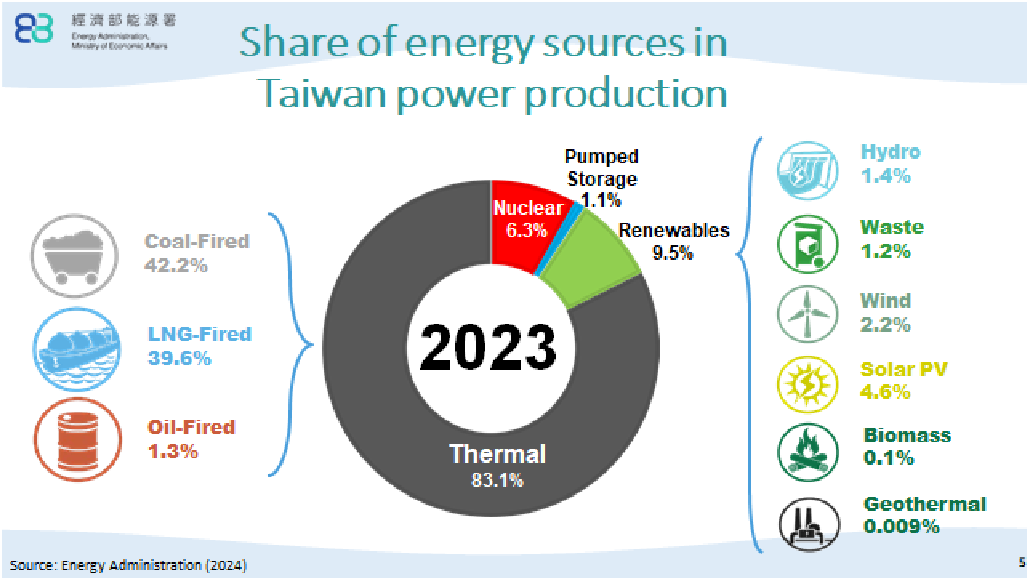
Critical to successful clean energy transition

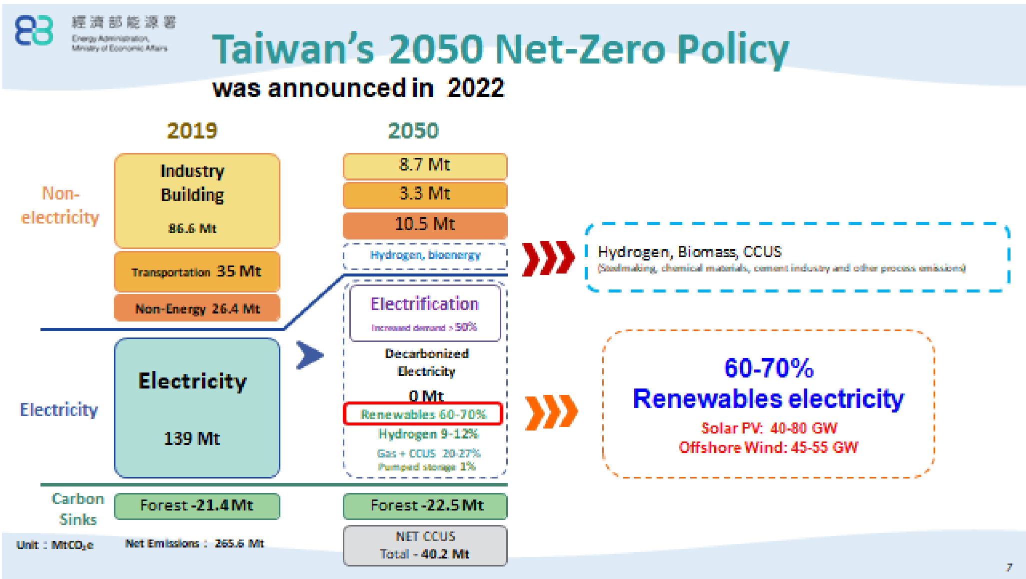
Partnerships for INFRASTRUCTURE

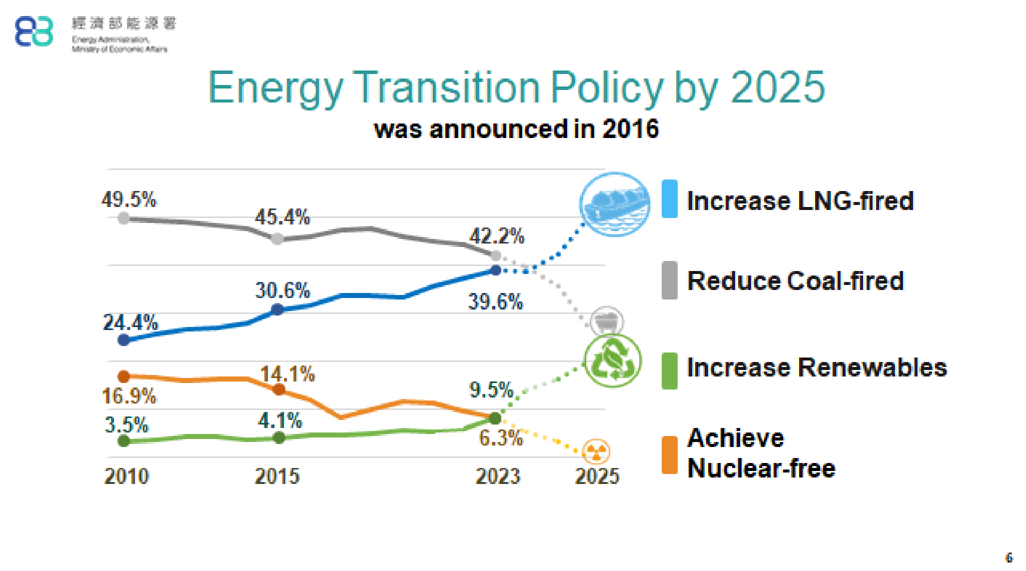
附件 3 能源署分享臺灣風力發電政策與推動成果



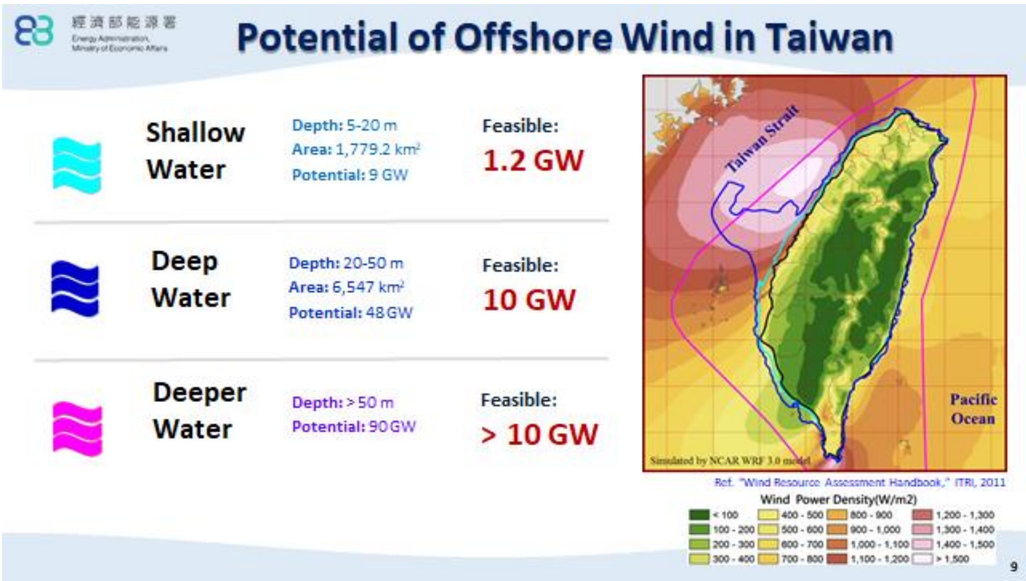

經濟部能源署
Energy Mix(2023)
96.9% Imported
3.1% Indigenous
Crude Oil & Petroleum Products 43.8%
LNG 20.3%
Nuclear 3.9%
Indigenous 3.1%
131.30 (MLOE)
Coal & Coal Products 28.9%
Others, 4.6%
Wind, 14.4%
Biomass and Waste, 41.2%
Solar PV, 30.0%
Geothermal, 0.5%
Hydro, 9.2%
Source: Energy Administration (2024)
4

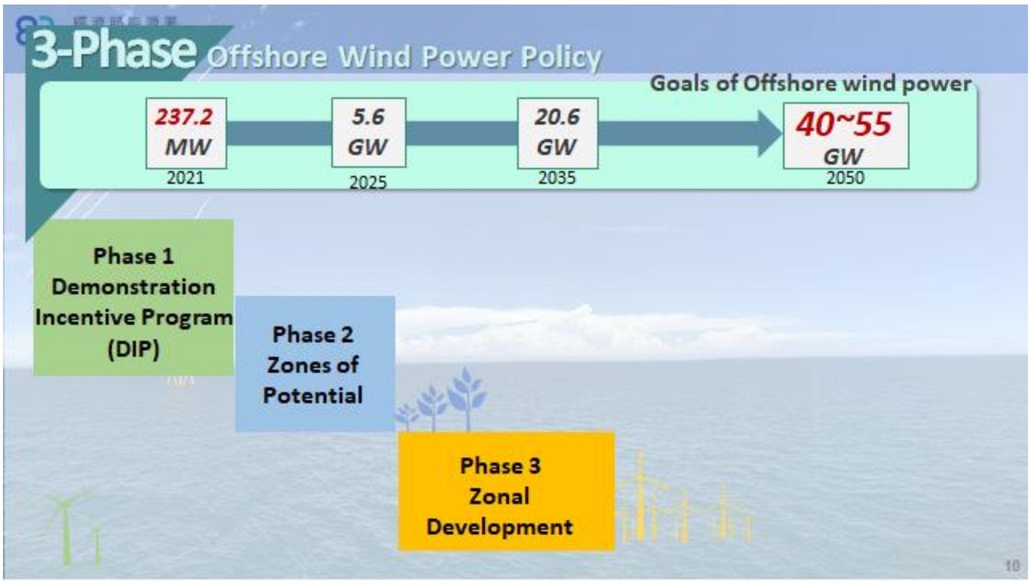

經濟部能源署
Share of energy sources in Taiwan power production
Coal-Fired 42.2%
LNG-Fired 39.6%
Oil-Fired 1.3%
Nuclear 6.3%
Pumped Storage 1.1%
Renewables 9.5%
2023
Thermal 83.1%
Hydro 1.4%
Waste 1.2%
Wind 2.2%
Solar PV 4.6%
Biomass 0.1%
Geothermal 0.009%
Source: Energy Administration (2024)
5

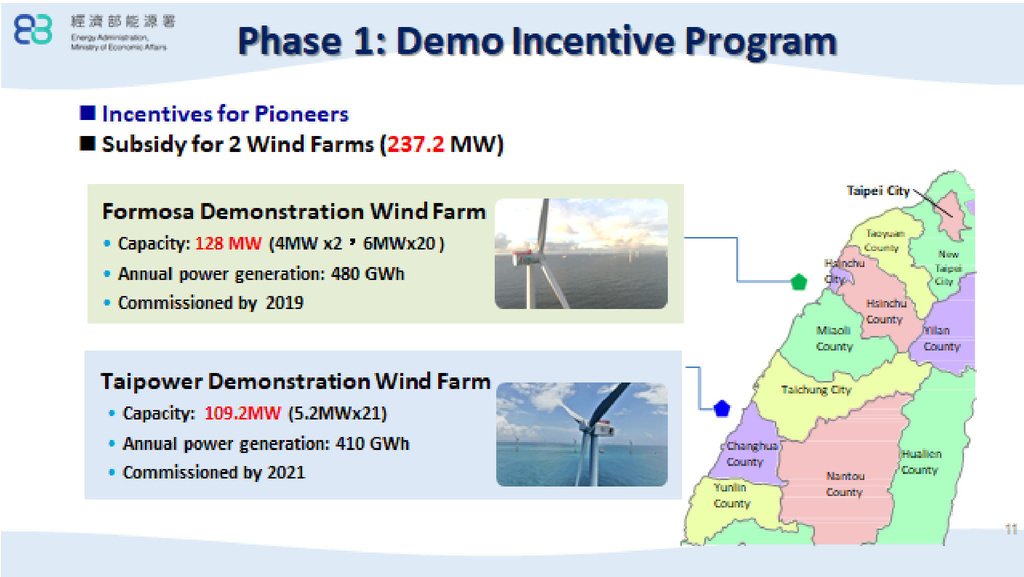

經濟部能源署
Taiwan's 2050 Net-Zero Policy
was announced in 2022
2019
2050
Non-electricity
Industry Building 86.6 Mt
Transportation 35 Mt
Non-Energy 26.4 Mt
8.7 Mt
3.3 Mt
10.5 Mt
Hydrogen, bioenergy
Hydrogen, Biomass, CCUS
(Steelmaking, chemical materials, cement industry and other process emissions)
Electricity
Electricity 139 Mt
Electrification
Increased demand >50%
Decarbonized Electricity
0 Mt
Renewables 60-70%
Hydrogen 9-12%
Gas + CCUS 20-27%
Pumped storage 1%
60-70% Renewables electricity
Solar PV: 40-80 GW
Offshore Wind: 45-55 GW
Carbon Sinks
Forest -21.4 Mt
Forest -22.5 Mt
NET CCUS Total - 40.2 Mt
Unit: MtCO₂e
Net Emissions: 265.6 Mt
7

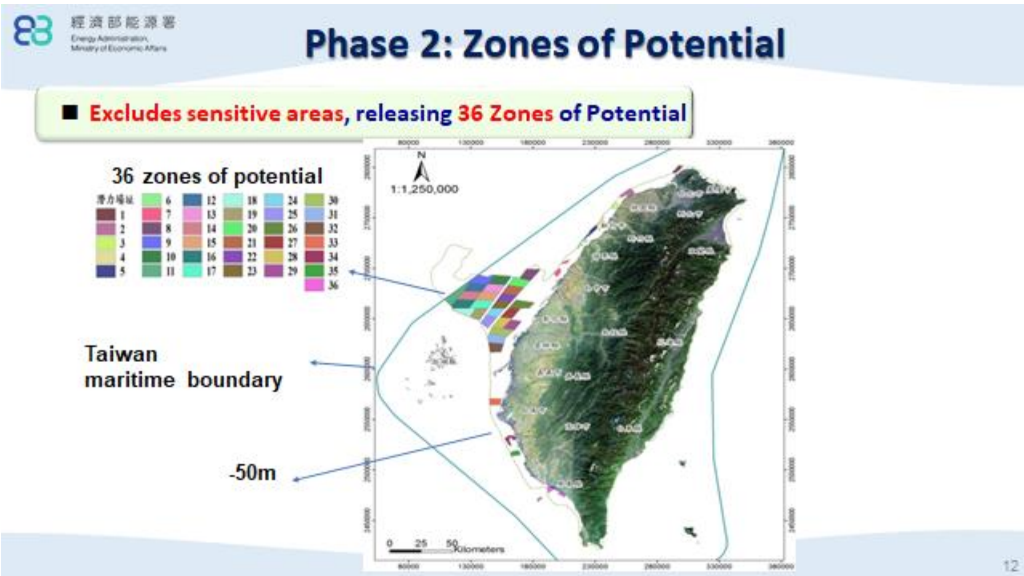

Energy Transition Policy by 2025
was announced in 2016
49.5%
45.4%
42.2%
24.4%
30.6%
39.6%
16.9%
14.1%
9.5%
3.5%
4.1%
6.3%
2010
2015
2023
2025
Increase LNG-fired
Reduce Coal-fired
Increase Renewables
Achieve
Nuclear-free
6

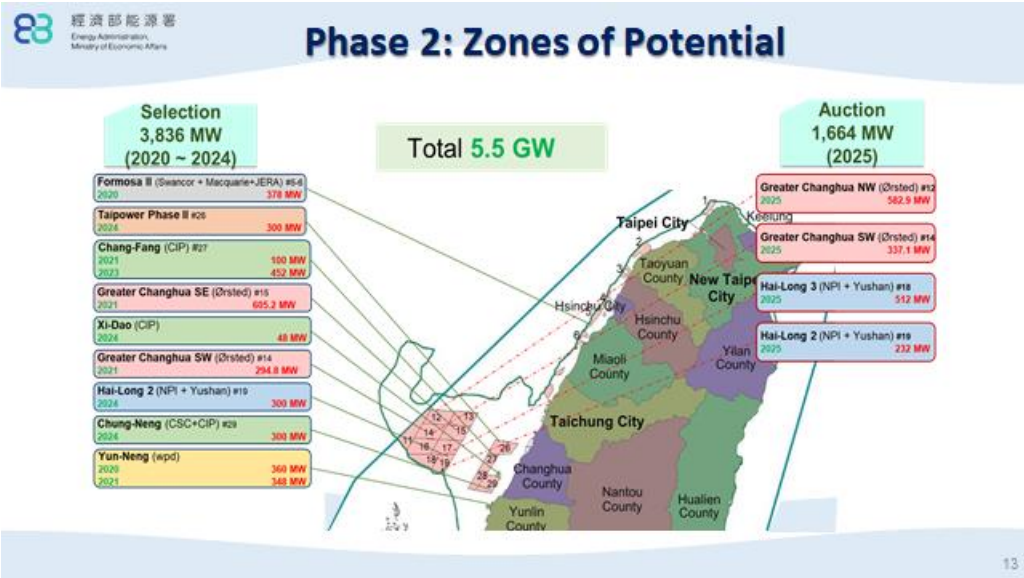

02
The Achievement of
Offshore Wind in Taiwan


Potential of Offshore Wind in Taiwan
Shallow Water
Depth: 5-20 m
Area: 1,779.2 km²
Potential: 9 GW
Feasible:
1.2 GW
Deep Water
Depth: 20-50 m
Area: 6,547 km²
Potential: 48 GW
Feasible:
10 GW
Deeper Water
Depth: > 50 m
Potential: 90 GW
Feasible:
> 10 GW
Taiwan Strait
Pacific Ocean
Ref. "Wind Resource Assessment Handbook," ITRI, 2011
Wind Power Density(W/m2)
9

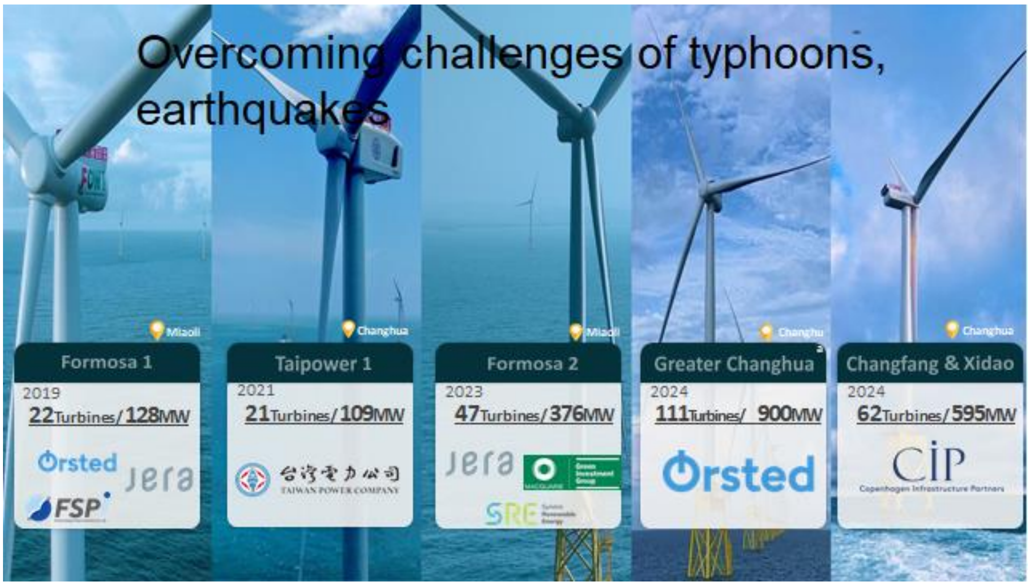

3-Phase Offshore Wind Power Policy
Goals of Offshore wind power
237.2 MW
2021
5.6 GW
2025
20.6 GW
2035
40~55 GW
2050
Phase 1
Demonstration
Incentive Program
(DIP)
Phase 2
Zones of
Potential
Phase 3
Zonal
Development
10

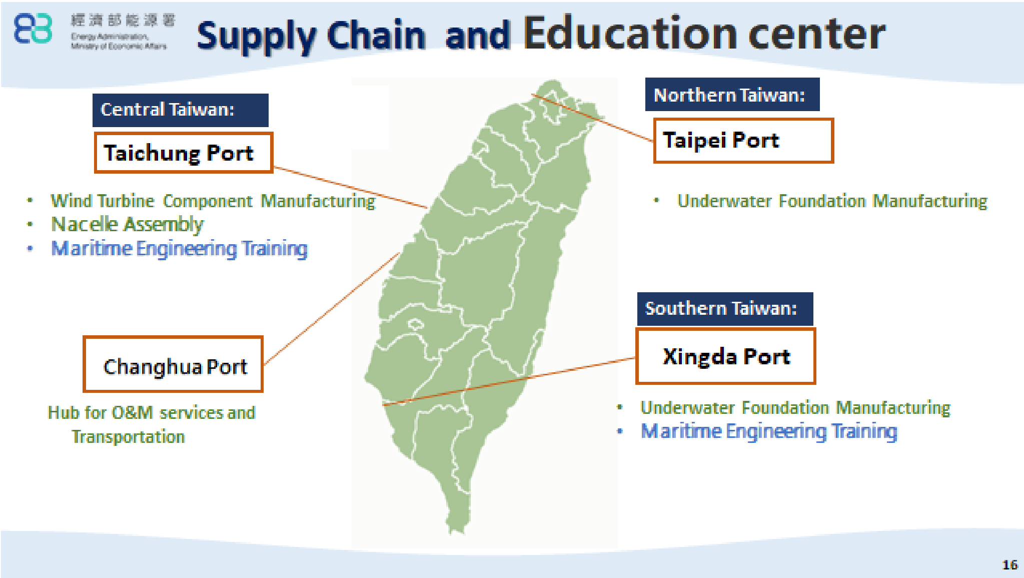

經濟部能源署
Phase 1: Demo Incentive Program
Incentives for Pioneers
Subsidy for 2 Wind Farms (237.2 MW)
Formosa Demonstration Wind Farm
Capacity: 128 MW (4MW x2 , 6MWx20)
Annual power generation: 480 GWh
Commissioned by 2019
Taipower Demonstration Wind Farm
Capacity: 109.2MW (5.2MWx21)
Annual power generation: 410 GWh
Commissioned by 2021
Taipei City
Taoyuan County
New Taipei City
Hsinchu City
Hsinchu County
Miaoli County
Yilan County
Taichung City
Changhua County
Hualien County
Nantou County
Yunlin County
11


經濟部能源署
Phase 2: Zones of Potential
Excludes sensitive areas, releasing 36 Zones of Potential
36 zones of potential
Taiwan maritime boundary
-50m
N
1:1,250,000
Kilometers
12


經濟部能源署
Energy Administration, Ministry of Economic Affairs
Phase 2: Zones of Potential
Selection
3,836 MW
(2020 ~ 2024)
Total 5.5 GW
Auction
1,664 MW
(2025)
Formosa II (Swancor + Macquarie+JERA) #5-6 2020 378 MW
Taipower Phase II #26 2024 300 MW
Chang-Fang (CIP) #27 2021 100 MW 2023 452 MW
Greater Changhua SE (Ørsted) #15 2021 605.2 MW
Xi-Dao (CIP) 2024 48 MW
Greater Changhua SW (Ørsted) #14 2021 294.8 MW
Hai-Long 2 (NPI + Yushan) #19 2024 300 MW
Chung-Neng (CSC+CIP) #29 2024 300 MW
Yun-Neng (wpd) 2020 360 MW 2021 348 MW
Greater Changhua NW (Ørsted) #12 2025 582.9 MW
Greater Changhua SW (Ørsted) #14 2025 337.1 MW
Hai-Long 3 (NPI + Yushan) #18 2025 512 MW
Hai-Long 2 (NPI + Yushan) #19 2025 232 MW
Taipei City
Keelung
Taoyuan County
New Taipei City
Hsinchu City
Hsinchu County
Miaoli County
Yilan County
Taichung City
Changhua County
Nantou County
Hualien County
Yunlin County
13

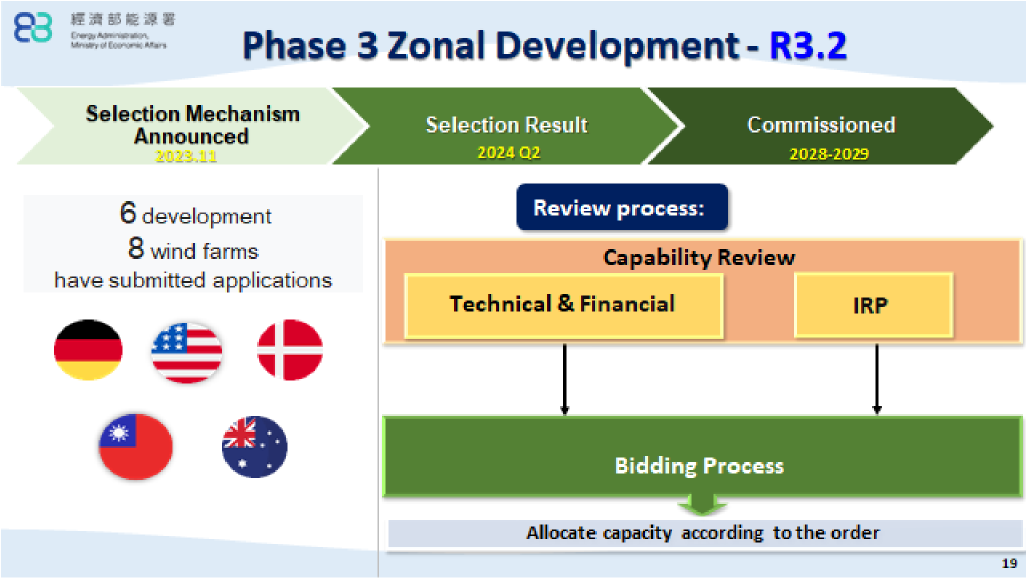

經濟部能源署
Energy Administration, Ministry of Economic Affairs
Public-private Collaboration
Competent Authority: MOEA
Policy Promotion: MOEA(經濟部), NSTC(國科會), MND(國防部), MOTC(交通部), MOI(內政部), OAC(海委會), MOA(農業部)
Industrial Development: MOEA
Technology Development: NSTC, MOEA
Local Talent Cultivation: MOTC, MOEA
1 Overcome the challenges of the pandemic
2 Mechanism for the use of maritime engineering vessels
3 Active coordination with the fishing industry


Overcoming challenges of typhoons, earthquakes
Miaoli
Formosa 1
2019
22Turbines/128MW
Ørsted
JERA
FSP
Changhua
Taipower 1
2021
21Turbines/109MW
台灣電力公司
TAIWAN POWER COMPANY
Miaoli
Formosa 2
2023
47Turbines/376MW
JERA
SRE
Changhua
Greater Changhua
2024
111Turbines/ 900MW
Ørsted
Changhua
Changfang & Xidao
2024
62Turbines/595MW
CIP
Copenhagen Infrastructure Partners

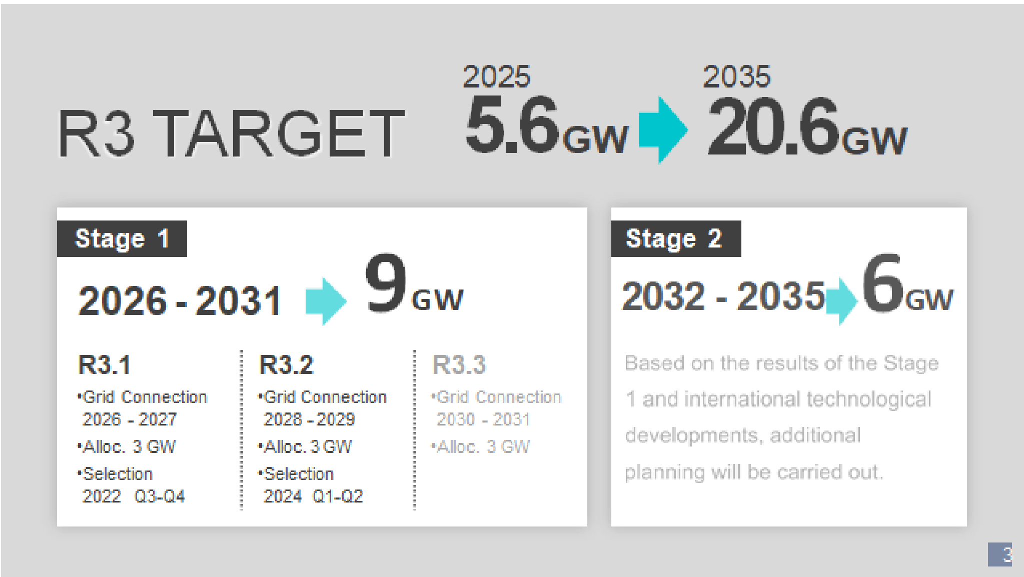

Supply Chain and Education center
Central Taiwan:
Taichung Port
Wind Turbine Component Manufacturing
Nacelle Assembly
Maritime Engineering Training
Changhua Port
Hub for O&M services and Transportation
Northern Taiwan:
Taipei Port
Underwater Foundation Manufacturing
Southern Taiwan:
Xingda Port
Underwater Foundation Manufacturing
Maritime Engineering Training
16

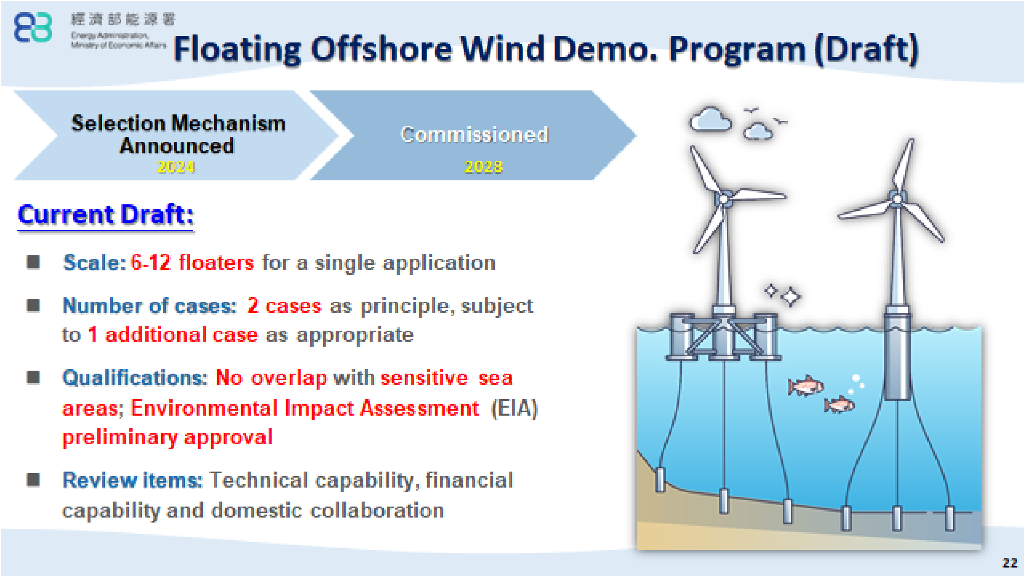

Phase 3: Zones Development
MOEA works Closely with offshore wind industry & Optimize mechanism
Round 2
Round 3
1 GW/yr
100% IRP
Market Expansion
Increased Flexibility
1.5 GW/yr
60% IRP(R3.1)
Fully-Optional (R3.2)
5


Phase 3 Zonal Development - R3.1
5 wind farms have signed the administrative contracts.
Formosa 4
Fengmiao
Haiding 2
Huanyang
Haixia
18


Phase 3 Zonal Development - R3.2
Selection Mechanism Announced
2023.11
Selection Result
2024 Q2
Commissioned
2028-2029
6 development
8 wind farms
have submitted applications
Review process:
Capability Review
Technical & Financial
IRP
Bidding Process
Allocate capacity according to the order
19


03
Future Plan for
Offshore Wind in Taiwan
20


R3 TARGET
2025
5.6GW
2035
20.6GW
Stage 1
2026 - 2031
9GW
R3.1
•Grid Connection 2026 - 2027
•Alloc. 3 GW
•Selection 2022 Q3-Q4
R3.2
•Grid Connection 2028 - 2029
•Alloc. 3 GW
•Selection 2024 Q1-Q2
R3.3
•Grid Connection 2030 - 2031
•Alloc. 3 GW
Stage 2
2032 - 2035
6GW
Based on the results of the Stage 1 and international technological developments, additional planning will be carried out.


經濟部能源署
Energy Administration, Ministry of Economic Affairs
Floating Offshore Wind Demo. Program (Draft)
Selection Mechanism Announced
2024
Commissioned
2028
Current Draft:
Scale: 6-12 floaters for a single application
Number of cases: 2 cases as principle, subject to 1 additional case as appropriate
Qualifications: No overlap with sensitive sea areas; Environmental Impact Assessment (EIA) preliminary approval
Review items: Technical capability, financial capability and domestic collaboration
22


經濟部能源署
Energy Administration, Ministry of Economic Affairs
04
Conclusion
23


We will continue to follow our policy of Phase 3 Zonal Development and aim to complete 20.6 GW by 2035.
International developers and banks are invited to further invest in Taiwan's offshore wind power market.
Phase 1 & Phase 2
Ørsted 沃旭能源
SRE
sojitz
力麗集團 LEALEA GROUP
CIP
台灣電力公司 TAIWAN POWER COMPANY
Jera
Stonepeak
NORTHLAND POWER
中鋼公司
EGCO
CDPQ
TotalEnergies
skyborn renewables
GLOBAL INFRASTRUCTURE PARTNERS
Phase 3
CORIO
IBERDROLA
台灣中油
EDF renouvelables
BlueFloat
infraVest
VENA ENERGY
FLOTATION ENERGY
台亞風能
6


經濟部能源署
Energy Administration, Ministry of Economic Affairs
Conclusion
The selection mechanism of R3.2 has been announced in Nov., 2023. It is expected that the selection results will be finalized in 2024 Q2.
WELCOME TO TAIWAN！ We encourage collaboration between domestic and international industry to ensure the sustainable development of offshore wind power in Taiwan.
Let's TEAM UP for Offshore Wind！
We welcome your investment in Taiwan. Together, we can strengthen Taiwan's offshore wind power industry.
25


經濟部能源署
Energy Administration,
Ministry of Economic Affairs
Thank you for your attention
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